Commissioned Article

Special considerations for prescription of glasses in children

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The most common cause of visual impairment in children is refractive error. All general ophthalmologists and most specialists come across children in their practice and treating a refractive error is the basic moral responsibility of any ophthalmic caregiver. Limited cooperation, low reliability, and risk of amblyopia make prescribing glasses for children more challenging than for adults. The basic rules of prescribing glasses take into account the visual needs according to age, strong accommodative elements, risk of amblyopia, age-related emmetropization, and associated conditions like strabismus, prior to prescribing glasses for children. This article focuses on the standard protocols of assessment and prescription of glasses for simple refractive errors as well as some special refractive situations in children.

Key words: Amblyopia, children, glasses, refraction, refractive error

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Refractive error is the most common cause of reduced vision in children, affecting 2 to 11% of the population below 16 years of age.[1,2] It is also responsible for 60 to 80% of visual impairment in children.[3,4] It is the responsibility of every ophthalmologist to reduce the number of this form of preventable blindness.

Prescribing glasses for children is always a challenge due to limited cooperation, low reliability in vision assessment, and risk of amblyopia. One must take into account the visual needs according to age, strong accommodative elements, risk of amblyopia, age-related emmetropization, and associated conditions like strabismus, prior to prescribing glasses for children. Until the age of six to seven years, prescription of glasses is primarily done on objective findings rather than on subjective refraction; this is mainly due to limited reliability and strong accommodation. Apart from refraction a complete eye examination should be done before prescribing glasses for the first time. This article focuses on the standard protocols of assessment and prescription of glasses for simple refractive errors as well as for some special refractive situations in children.

Assessment of refractive error

Cycloplegic refraction is a rule in children due to the presence of strong accommodation. This is done to reveal the total refractive status of the eye with the accommodation at rest. A dry retinoscopy can be done prior to cycloplegia to assess the accommodative effort and to get a rough estimate of the refractive error. To begin with, visual assessment should be done, one eye at a time, using the age-appropriate methods:

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Less than 2.5 years: Fixation and following movements, preferential looking charts (Cardiff cards), objection to cover, fixation preference, and cake sprinkles.

2.5 years to 4 years: Symbol / Alphabet matching cards (e.g., Allens, HOTV, Lea symbols)

Above 4 years: Snellen's / LogMAR chart

A complete eye examination should include a cover test, extraocular movements, convergence, anterior segment, and fundus examination. A complete squint examination is done if strabismus is detected. The cycloplegic agents most commonly used are as follows:

Atropine (1%) eye ointment is the strongest cycloplegic agent, which is instilled twice a day for three days prior to the refraction (retinoscopy). The parents should be warned that the child will experience blurred vision and photophobia for a period of 10 to 14 days. Also, some children may experience flushing of the face, confusion, tachycardia or an allergic reaction. The possibility of this should also be explained to the parents when atropine is prescribed for the first time. Atropine eye drops have a higher chance of being absorbed systemically via the nasolacrimal passage, and thus, atropine eye ointment and punctal pressure is preferred, especially in infants. The more commonly used regimen for cycloplegia includes cyclopentolate (1%) eye drops instilled twice followed by tropicamide (0.8%) with phenylephrine (5%), commercially available combination eye drops, once, at 5 minute intervals. Retinoscopy should be performed about 45 minutes after the first drop is instilled. This regimen is found to induce comparable cycloplegia to atropine (1%) with a maximum undercorrection of + 0.5 D Sph. In infants (< 1 year) the cyclopentolate (1%) should be diluted (with water for injection) to 0.5%, to avoid side effects like flushing of the face, confusion, and tachycardia.

The gold standard of objective refraction is retinoscopy although the newer autorefractometers do give comparable results. Autorefractometers induce some amount of proximal convergence, and thus, in turn produce some accommodation,

in spite of the cycloplegia, leading to a mild undercorrection of the hypermetropia. Also, in young, uncooperative children, it is difficult to convince the child to place the head on to the autorefractometer, although hand-held autorefractometers help overcome this problem. It goes without saying that the age-old skill of retinoscopy is a vital aid in calculating the accurate refractive error in children. Streak retinoscopes as well as plane mirror retinoscopy give similar results.

Factors to consider prior to prescription of glasses

The refractive status of a child is constantly changing with age. Neonates are normally hypermetropic, with minimal astigmatism. This hypermetropia is usually symmetrical, which is usually less than 4 D. The astigmatism is also less than 2 D. Both the hypermetropia and astigmatism reduce with age. This emmetropization has to be taken into account with regard to age and refractive error. A child below the age of two years has minimal interest in distant objects, and thus, a small myopic correction is not required to be prescribed until this age. Taking into account the visual needs of a child, hypermetropia is corrected earlier than myopia Also, risk of amblyopia is dependent on the magnitude of the refractive error, type of refractive error (lesser risk in myopes, as near vision is clear), as well as age of the child.[5] Anisometropia is the most common cause of amblyopia.[5] The presence of strabismus also plays a vital role in the decision making of glass prescription for children. Finally, the strong accommodation should be taken into account by performing cycloplegic refraction in all children prior to prescribing glasses. Thus, to summarize, age-related emmetropization, visual needs of the child, visual assessment of the child, amblyopia, strabismus, magnitude and type of refractive error, and strong accommodation are some of the factors that one has to consider before prescribing glasses. Following are some of the rules of prescription, based on the type of refractive error.

Rules of prescription

Hypermetropia

Children have a strong accommodation, which can overcome minimal amounts of hypermetropia with ease. A plus power of more than 5 D becomes difficult to overcome; also the amount of accommodation needed for near tasks would then be in the range of + 8 D, which can easily cause asthenopia. Children with a weak accommodation can have asthenopia at lower powers. Amblyopia and esotropia are the most common outcomes of uncorrected hypermetropia. Amblyopia can occur if the child cannot overcome hypermetropia at all times, especially for near vision. Also, lower amounts of hypermetropia can lead to a refractive accommodative esotropia, further increasing the risk for amblyopia; thus, the presence of strabismus must always be checked in these children.

The amount of hypermetropia that needs to be corrected depends on the age although a power of around 5 D needs to be corrected due to the risks of amblyopia. Please refer to the American Association for Pediatric Ophthalmology and Strabismus (AAPOS) guidelines given below [Table 1]. As long as there is no esotropia, a mild undercorrection (reduce by 0.75D) can be prescribed, to allow for some accommodation to occur. Undercorrection should always be equally done in both eyes, as accommodation is a binocular phenomenon. It is thus extremely important to perform a cover test in all children with hypermetropia, to rule out the presence of esotropia. If the accommodation is weak, then a full cycloplegic correction is considered.

Hypermetropia with esotropia

In cases of esotropia even smaller amounts (> 1.5 D) of hypermetropia should be corrected by prescribing the full cycloplegic correction. Refractive accommodative esotropia commonly occurs in the age range of two to four years. Esotropia is often intermittent to begin with and can then progress to a constant strabismus over time. A cover test is mandatory in all children with suspected hypermetropia prior to instillation of cycloplegic eye drops. Performing cycloplegia with atropine is recommended, at least for the first time, to ensure full prescription of the hypermetropia in these children.[6] It is the moderate hypermetropes (2.5 to 5 D) that present with accommodative esotropia, while the higher hypermetropes do not squint, due to lack of accommodative effort for such a high power.

Myopia

Myopia (less than 3-5 D) does not pose a high risk of amblyopia, as near vision is almost always unaffected except in the high myopes. The prescription of glasses in low myopes is best done at a pre-school age of three to four years, as this is the age the children start having significant hours of distant viewing. Prescription of glasses should be considered earlier if the power is beyond the range of 3 to 5 D. The aim is to prescribe the lowest minus power needed for best visual acuity and over-correction should definitely be avoided. As small children will not give reliable responses to the duochrome test, the value on cycloplegia would be close to the least minus power the eye may need. The other guide for prescription of low minus powers is the distant visual acuity of older children and their school requirements according to age. Please refer to the AAPOS guidelines below [Table 1]. Intermittent exotropes should be prescribed even with the smallest myopic correction with the aim of inducing convergence, to overcome exotropia.

Astigmatism

Accommodation can change only the spherical refractive status of the eye by a change in the curvature of the crystalline lens. Astigmatism cannot be overcome by accommodation, and thus, any cylindrical power above 1.5 to 2 D can be amblyogenic. Cylindrical powers beyond this range should be prescribed, again based on the age of the child. Please refer to the AAPOS guidelines below [Table 1]. As opposed to adults the total cylindrical power is prescribed in children with the aim of correcting both the meridians entirely, thus preventing any chance of amblyopia. Children accept high cylindrical powers far more easily than adults and no attempt to undercorrect should be made, at least in the younger children. Smaller cylindrical powers (< 1.5 D) should be prescribed in older children if visual acuity is mildly reduced and also in children who primarily have spherical powers with additional small cylindrical powers. Spectacle fitting and

centration is extremely important in the higher cylindrical powers. Parents should be explained the importance of centration, as children often bend their frames and prompt repair and tightening will ensure optimum benefit of the glasses at all times.

Anisometropia

Hypermetropic anisometropia is more amblyogenic then myopic anisometropia. A difference of > 1.5 D of hypermetropia is considered amblyogenic and should be prescribed early. Myopia on the other hand can be overcomed by accommodation and a myopic anisometropia of up to 3 D can be considered as a very low risk of amblyopia. Thus, any difference beyond 3 D should be prescribed early. Eventually a unilateral myope of up to 3 D will need glasses by pre-school age. Similar to hypermetropia, astigmatism of > 1.5 D is also amblyogenic and should be prescribed early.

Extra tips

1. Vision assessment is more accurately possible by 2.5 years of age and can also be taken as a guide to prescribe glasses. Children of this age would only cooperate for matching charts with single optotypes, which tend to underdiagnose amblyopia due to the absence of the crowding phenomenon. This should be taken into account before starting amblyopia therapy.
2. In younger children the above rules serve as important guidelines to prescribe glasses. The amount of refractive error that needs to be corrected is based on the risks of amblyopia with that error, for that age.
3. More than 80% of the children can cope with a high powered prescription for the first time, and thus, prescribing undercorrected lenses for better compliance may be needed in only less than 20% of the children. Thus, prescribing the full correction in the first instance is recommended to save time and resources, but undercorrection should be considered if the child is not wearing the glasses in spite of sincere attempts by the parents for more than four months.
4. Hyperopes can be prescribed cycloplegic drops like atropine or homatropine for a couple of weeks to help relax the accommodation and get used to the high plus power.
5. Myopes on the other hand respond and get used to glasses more easily, especially if they have started doing distant visual activities.
6. Astigmatic children often need convincing to start using their glasses, due to a very small difference in the visual clarity on correcting small cylindrical errors.
7. After prescribing glasses for the first time, the patient must be reviewed in six to eight weeks to assess the compliance and the vision with glasses. This time is usually adequate for the parents to ensure that the child is using the glasses most of the day. Treatment of amblyopia in the form of patching or penalization can be started only after this.

Special Situations

Intermittent Exotropia

Intermittent exotropia is a condition in which there is a loss of fusion for brief periods of time during which the eyes go into a divergent squint. This varies in frequency and duration based on a number of factors. Prescribing concave lenses induces convergence and helps reduce the frequency of the exotropia. The general rules of prescription in exotropes are as follows:

1. Any refractive error resulting in reduced vision should be corrected to improve fusion
2. Minor amounts of myopia should also be corrected
3. Hypermetropia with normal vision does not warrant a prescription, as it reduces the need to converge.
4. High hypermetropia with reduced vision should be prescribed, but undercorrected.

The aim of treating intermittent exotropia: Prescription of concave lenses is a conservative yet effective modality for improving the control of the intermittent exotropia during the time the glasses are being used by the child. Some studies have shown that prescribing a low minus power (- 1.5 D) in patients who do not have myopia also has beneficial effects, although some children can have asthenopia, and also it is difficult to convince the parents regarding the use of glasses when the child does not need them for vision.

Table 1: American Association for Pediatric Ophthalmology and Strabismus guidelines for prescription of glasses for children[7]

Condition	Diopters beyond which glasses should be considered		
	Age 0-1 years	Age 1-2 years	Age 2-3 years
Isometropia			
Myopia	≥ - 4.00	≥ - 4.00	≥ - 3.00
Hyperopia (no eso)	≥ + 6.00	≥ + 5.00	≥ + 4.50
Hyperopia (eso)	≥ + 2.00	≥ + 2.00	≥ + 1.50
Astigmatism	≥ 3.00	≥ 2.50	≥ 2.00
Anisometropia			
Myopia	≥ - 2.50	≥ - 2.50	≥ - 2.00
Hyperopia	≥ + 2.50	≥ + 2.00	≥ + 1.50
Astigmatism	≥ 2.50	≥ 2.00	≥ 2.00

Progressive addition lenses for progressive myopia

A number of studies have been published in the last decade on the role of progressive addition lenses (PALs) for progressive myopia. The basis of these studies, the Correction of Myopia Evaluation Trial (COMET), states that some myopic children have a weak accommodation or accommodation lag, which leads to a retinal defocus for a near object (< 50 cm) producing an image behind the retina.[8] This retinal defocus is a stimulus for the growth of the eye-ball. Thus, prescribing addition lenses in myopic children with accommodation lag ensures a clear image of the near object, getting rid of the retinal defocus. This can lead to reduction in the progression of the myopia. Progressive glasses

have been preferred over bifocals, as they produce a clear image at all distances. These comparative studies have claimed that these children do progress less than their counterparts who wear single vision glasses, although the results are not so significantly different to warrant a change of practice. They start by prescribing anywhere from a plus 1.5D to 3.0D addition, based on the amount of accommodation lag. This modality is used by a few pediatric ophthalmologists only for rapidly progressing myopia.

High AC/A ratio

Children who have an esotropia that measures more for near fixation as compared to distance fixation (by 10 to 15 PD) should be checked for a high AC/A ratio (normal 5:1). There are two methods for checking the AC/A ratio.

Gradient method can be used in two ways:

- (Deviation for near) - (deviation for near with + 3 D sph) divide by 3
- (Deviation for distance with – 3 D sph) - (deviation for distance) divide by 3

Heterophoria method is the preferred method and is as follows:

- IPD (in cm) + (Deviation for near) – (deviation for distance) divide by diopteric power needed to read at near (33 cm)

In children with a high AC/A ratio, prescribing the full cycloplegic distance correction can correct the distance deviation completely, but the near deviation may persist. These children should be prescribed bifocals to correct the near deviation as well. One can start with an addition of plus 2.50 to 3.00 D sph, which later can be reduced based on the response. It is important to see the effect of the distance glasses on the deviation by first prescribing only single vision glasses and then considering bifocals, only if near deviation (> 10 pd) persists. In case the distance deviation only reduces by a small amount with single vision glasses, but does not come within 10 pd of orthophoria, then surgery should be offered and not bifocals. Bifocals should ideally be the executive style with the reading segment bisecting the pupil. This ensures that the child starts using the near segment with minimal depression of eyes and one does not rely on the child using the near segment on near tasks. Specific instructions should be given to the opticians to make the reading segments at the level of the pupil, which is usually higher than when prescribed in adults. Executive glasses are expensive and a flat top 'D' bifocal segment is an alternative to it.

Prescription after cataract surgery

Bilateral aphakia

Bilateral cataracts in neonates are often treated with bilateral cataract extraction, with posterior capsulotomy and anterior vitrectomy. These babies can be prescribed aphakic glasses or contact lenses. Although contact lenses have significant advantages over glasses in this situation, risks of infection, training parents, and the cost factor, limit its use and aphakic glasses are the only other alternative. Contact lens fitting is beyond the topic of this article. Retinoscopy should be performed after dilating the pupil, although no cycloplegia is needed as the eye is aphakic. After taking away the working distance an addition of + 2.00 to + 3.00 D sph is added to the correction. This ensures that the child is corrected for near activities in the absence of accommodation. Infants mainly have an interest in objects within a few feet from the face. This addition can be reduced as the child grows older and bifocals should be considered by one-and-a-half to two years of age. This reduction of the addition is approximately based on the age and near activities of the child. Executive bifocals at the level of the pupil are preferred for the same reasons mentioned earlier.

Unilateral Aphakia

If only a unilateral cataract exists, then placing an intraocular lens or using a contact lens becomes extremely vital, as unilateral aphakic glasses cannot be prescribed due to extreme aniseikonia.

Pseudophakia

Children who have undergone cataract surgery with intraocular implants should be prescribed the entire spherical and cylindrical power calculated on a dilated retinoscopy. These children are usually older than a year, and thus, executive bifocals of + 2.50 to 3.00 D sph should be prescribed at the level of the pupil. Any glass prescribed after cataract surgery should ideally have an ultraviolet (UV) protective coating, as the natural protection of the crystalline lens is absent, although most of the intraocular lens (IOLs) now have UV protection properties.

Polycarbonate glasses

Ideally all glasses in children should be made with polycarbonate material. It is not only shatter-resistant but also has an inherent property of UV protection. The only disadvantage of this material is that it is expensive. It should definitely be prescribed for one-eyed children or children with a precious eye like in the case of monocular gross amblyopia or corneal injury. It is often prescribed only during sporting activities, to avoid injury to a precious eye.

Tinted glasses / Photochromatic lenses / Utraviolet protection

Tinted and photochromatic lenses should not be routinely prescribed for children because they can affect visual contrast while indoors. These lenses should be reserved for children with albinism and aniridia. An amber tint is prescribed for aniridia and albinism. UV-rays have been implicated as a risk factor in a number of eye conditions. The presence of a tint does not provide UV protection. In fact tinted glasses without UV protection are more harmful than untinted glasses, as the tint causes dilatation of the pupil, which allows more light to enter the eyes, thus causing more UV damage. The level of UV protection is recognized by the 'nm 400 mark' or the '99 – 100% UV protected' instruction on the glasses. However, mainly prescription glasses can be UV protective by adding a coating on the lenses or by having the lenses made of polycarbonate material.

Conclusion

Prescription of glasses in children is not the same as prescribing them in adults. Accommodation, visual requirements, emmetropization, amblyopic age, and ocular alignment should be taken into account before prescribing the glasses. Cycloplegic retinoscopy is a must in all patients and the prescription can be then based on the amblyogenic potential of that power, calculated for that age, by following the basic rules, as discussed earlier in the

text. Special situations like strabismus can only be considered if detected, and thus, a cover test should be performed in all children prior to prescribing glasses. Detection and accurate prescription of glasses in children is possible only if the general ophthalmologist is aware of these basic steps of assessment and prescription.

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